(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: 0 017 983 B1

(12) EUROPEAN PATENT SPECIFICATION

(45) Date of publication of patent specification: 25.07.84

(51) Int. Cl.[3]: B 65 H 3/10, B 65 H 3/46, G 06 K 13/107

(21) Application number: 80102049.6

(22) Date of filing: 16.04.80

(54) Sheet transport apparatus.

(30) Priority: 20.04.79 JP 48713/79
25.10.79 JP 137966/79

(43) Date of publication of application:
29.10.80 Bulletin 80/22

(45) Publication of the grant of the patent:
25.07.84 Bulletin 84/30

(84) Designated Contracting States:
CH DE FR GB LI NL

(56) References cited:
DE - A - 2 454 082
DE - C - 1 007 340
DE - C - 1 107 675
GB - A - 849 797
US - A - 3 954 260

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EP 0 017 983 B1

Description

This invention relates to sheet transport apparatus for picking up and conveying successively sheets out of a stack.

Utilization of information reading devices to recognize the information contained in sheet-like materials, such as, for example data cards, stacked one upon another, needs each card to be fed successively to information reading devices in card-by-card manner. One type of prior art apparatus for feeding cards to information reading devices utilizes a continuously rotating suction drum which includes a rotating cylindrical member with an apertured curved surface portion. Provided within the cylindrical member is a stationary suction chamber extending axially along the curved surface and having a curved opening to face the inner surface of the cylindrical member with a certain clearance. The rotating suction drum functions to suck air near to the opening of the suction chamber but outside of the cylindrical member through apertures thereof when the apertured portion of the cylindrical member passes by the opening of the suction chamber (see GB—A—849 797).

Such a rotating suction drum is positioned near the leading edge portion of the top-positioned card or sheet of the stack of the sheets with a certain clearance so as to pull up the top-positioned sheet in the direction of movement of the periphery of the suction drum by the sucking operation thereof. Each top-positioned sheet is pulled up at the passing of the apertured curved surface portion of the suction drum. Thus, individual sheets are intended to be pulled up in a precise rhythm in one-by-one manner as the suction drum rotates, and fed to belt conveying systems which convey the sheets in the form of sheet train with a given distance between adjacent sheets.

The information reading devices read the information contained in such transported sheets and then sheets are stacked again in a predetermined position. It is necessary for reading the information from the stack of the sheet that the sheets are transported successively in one-by-one manner. It is also usually required that the distance between leading edges of adjacent sheets during transportion is approximately uniform.

Indeed the conventional sheet transport apparatus can effectively take sheets one after another from a stack. But it has some drawback to eliminate. More specifically, the drawback resides in the conveyor devices which constitute a belt conveyor system for receiving sheets pulled up from the suction drum in a precise rhythm and carrying them to a place.

The know belt conveyor system of the type described in DE—A—2 454 082 has two conveyor devices each having two endless belts in the form of a loop. The endless belts of one conveyor device run straight and parallel to those of the other conveyor device. Between the belts of one conveyor device on one hand and those of the other on the other hand sheets are clamped. These portions of the endless belts which sandwich sheets constitute a sheet-holding portion of the belt conveyor system. The sheets are fed from the suction drum to one end of the sheet-holding portion and carried to the other end thereof. Most of the sheets entering the sheet holding portion fail to be smoothly clamped between the endless belts. Rather, they may roll up or be fold in the guiding space, and in the worst case they may jam and may be wrinkled.

The object of this invention is to reduce the probability of occurrence of wrinkles or jams in the sheets and the occurrence of undesirable vibration in the sheets.

In order to achieve the above-mentioned object, a sheet transport apparatus according to this invention comprises means claimed in claim 1.

This invention can be more fully understood from the following detailed description when taken in conjunction with the accompanying drawings, in which:

Figure 1 shows a schematic side view, partly in cross section, of the sheet feed and transport apparatus of the invention;

Figure 2 shows a perspective view of the suction drum of the apparatus of Figure 1;

Figure 3 shows a cross-sectional view of the suction drum of Figure 2, taken along line A—A thereof, wherein the rotational position of the suction drum is advanced from that shown in Figure 2;

Figure 4 shows a schematic cross-sectional view of the suction drum of Figure 2, taken along line B—B thereof;

Figure 5 shows a schematic cross-sectional view of the suction drum of Figure 2, taken along line C—C thereof;

Figure 6 shows a schematic perspective view of the separation suction device of the embodiment of Figure 1; and

Figure 7 shows a schematic end view of the collecting device of the embodiment of Figure 1.

Throughout these Figures, identical or similar parts are indicated by the same reference numerals.

Referring to Figure 1, reference numerals 21 indicates a case for containing sheet-like materials such as sheets of paper or cards to be transported in the direction as indicated by the arrows in sheet-by-sheet manner.

The case 21 is generally box-like in shape and sufficiently open at the top to allow the sheets to be removed in a substantially horizontal plane. A stop bar member 22, which may be integral with the case 21, extends outwardly over a portion of the top of the case for defining the position of the top of the stack. Preferably the bar 22 overlies the trailing edges of the sheets as to their direction of movement.

Provided within the case 21 is a lift plate 24 which is spring-biased upwardly by a spring 23. The sheet-like materials, such as, for example, data cards, are stacked one upon another on the plate 24 to form a stack 25. This stack 25 is positioned in such a manner that the uppermost or top-positioned card 25a of the stack 25 is kept at a predetermined position by cooperation of engagement between stop bar member 22 and stack 25, and biasing force of spring 23.

The forward movement of the sheets 25 within the casing 21 is limited by abutment against a vertical surface 21a. In the preferred embodiment the surface 21a forms a portion of the wall of a vertically aligned separation suction device 26, the horizontal head of the suction device being positioned coplanar with or slightly above the plane of the topmost sheet 25a in the stack 25.

It is apparent that if desired, the vertical surface 21a could be formed by an integral portion of the casing 21 and the suction device 26 could adjoin the integral wall of the casing.

As shown in Figure 6, the suction device 26 is of box-like shape to form a chamber therein, the head of the device having apertures arranged in rows and columns. In the illustrated embodiment, there are 15 apertures in a matrix of 3 rows and 5 columns. The chamber of the suction device 26 is communicated with an evacuation device P_1 through a conduit 28. The purpose of the suction device 26 will be explained hereinafter.

Referring again to Figure 1, a suction drum, generally indicated at 29, is positioned above the case 21 such that the axis of the drum is parallel to, and slightly to the rear of, the projection of the vertical surface 21a. The curved surface of the drum 29 is substantially tangent to a plane parallel to the topmost sheet 25a but slightly separated therefrom to permit movement of the leading edge of the topmost sheet upward to the curved surface of the suction drum. This drum 29 has an axial width somewhat shorther than the width of the sheets 25, such as data cards, as can be seen from Figure 2, whereby both of side edges of the sheets extend beyond the width of the drum, as the sheets are advanced in their lengthwise direction.

Referring to Figures 3 and 4, suction drum 29 has a cylindrical member 29a with a flange portion 29b extending radially inwardly from one peripheral edge of its curved surface. The cylindrical member 29a includes an apertured curved surface. In more detail, the cylindrical member 29a has a plurality of apertures 30 disposed regularly about its curved surface in two diametrically opposite peripheral zones 30a and extending circumferentially by a predetermined distance. Mounted on such peripheral zones 30a are coverings 32 of sheet-like materials of relatively large coefficient of friction such as, for example, rubber sheets, and the coverings 32 have apertures 31, each corresponding to respective apertures 30 of the cylindrical member 29a. The cylindrical member 29a has, for example, a diameter of 127 mm under the conditions that the length of the cards in the transport direction is within a range from 50 mm to 200 mm and that the distance between leading edges of the adjacent cards during transportation is 300 mm.

Provided within the cylindrical member 29a is stationary suction chamber, generally indiciated at 33, to provide suction operation in cooperation with apertures 30 of the member 29a. A hollow stationary drum 34 (Figures 3 and 4) is provided coaxially within the cylindrical member 29a, and is secured coaxially to a bored and apertured stationary axis 35. The hollow portion of the drum 34 forms a chamber for communication between suction chamber 33 and the bore of the stationary axis 35 which, in turn, is connected to an evacuation pump P_2.

The suction chamber 33 is formed in the annular area between the drum 34 and the inner curved surface of the cylindrical member 29a by two longitudinal ribs 33a, 33b on the outer surface of the drum 34 extending radially outwardly to terminate near the inner surface of the cylindrical member 29a.

The drum 34 is apertured between the ribs 33a, 33b providing suction in the chamber 33 from the bored axis 35 through the space between the axis and the drum 34. The suction chamber 33 thus substantially extends across the width of the cylindrical member 29a.

The ribs 33a, 33b may be integral with the drum 34, or, if desired, the ribs and the arcuate wall interconnecting the ribs may be fabricated as a separate member and the arcuate wall portion inserted into an opening in the wall of the drum 34 as shown in Figure 4.

The circumferential distance between the opposing outer ends of the ribs 33a, 33b is slightly less than the circumferential length of the zone 30a of the apertured areas in the cylindrical member 29a.

The stationary suction chamber 33 is positioned such that the plane of the inner surface of the trailing rib 33a, in the direction of rotation of the cylindrical member 29a, is preferably about 3 to 8 mm to the rear of the plane of the surface 21a. In other words, the major portion of the circumferential length of the chamber 33 extends beyond the leading edges of the sheets in the stack 25 in the direction of movement of the sheets in transport.

Whenever the apertured curved surface of cylindrical member 29a overlaps the chamber 33 upon rotation of the cylindrical member, air near its apertured curved surface is sucked through the apertures 30 and 31 into the chamber 33. This suction operation functions to attract the data card 25a. Accordingly, the open side of the chamber 33 between the ribs 33a, 33b defines a potential suction zone. The potential suction zone has substantially the same width as the axial length of the cylin-